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BOTANICAL CONTENT OF BLACK-TAILED JACKRABBIT DIETS ON SEMIDESERT RANGELAND

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Abstract.—Botanical content of black-tailed jackrabbit diets was determined by microhistological examination of fecal samples collected from six different vegetation types in southern New Mexico on three dates. Grasses comprised the largest component of the jackrabbit diets, with dropseed species (*Sporobolus* spp.) and black grama (*Bouteloua eriopoda*) the most abundant grasses in the diets. Leatherweed croton (*Croton pottsii*) and silverleaf nightshade (*Solanum elaeagnifolium*) were important forbs on most vegetation types. Diet composition varied in response to season and vegetation type. Grasses were important during the summer growing season, while forbs were selected during their growing season (summer or winter-spring). Shrubs were less abundant in the diet than grasses and forbs.

Key words: microhistological analysis, fecal analysis, Lepus californicus.

Black-tailed jackrabbits (*Lepus californicus*) are widely distributed in western and central North America. They range from Canada southward to the states of Sonora and Chihuahua, Mexico, and from the Pacific coast eastward to the Great Plains (Hansen and Flinders 1969). Because of this wide distribution, jackrabbits encounter a variety of potential food sources (McAdoo and Young 1980). Considerable work has been conducted on food habits of the black-tailed jackrabbits, especially in Arizona, Colorado, and the Great Plains (Arnold 1942, Reigel 1942, Lechleitner 1958, Sparks 1968, Hansen and Flinders 1969, Flinders and Hansen 1972, Uresk 1978, Fagerstone et al. 1980, Johnson and Anderson 1984). These studies show that jackrabbits are opportunistic feeders, varying their diets depending on available forage.

In spite of the relatively large number of publications reporting the feeding habits of black-tailed jackrabbits, few have been conducted in New Mexico and the Southwest. Dabo et al. (1982) found jackrabbit diets were composed of many species, but only a few species of grasses and forbs formed the bulk of the diet. They found that diets, inferred from fecal analysis, differed among habitats for jackrabbits during summer and fall. In contrast, Fatchi et al. (1988) found similar diets among habitats on similar rangeland. The present study represents a continuation of earlier studies and should add to understanding seasonal and yearly fluctuations in diets of black-tailed jackrabbits.

Study Area

The study was conducted on the New Mexico State University College Ranch about 40 km north of Las Cruces, New Mexico. The ranch lies on the Jornada Plain between the San Andres Mountains and the Rio Grande at an elevation of about 1300 m (Wood 1969, Valentine 1970). The climate of the Jornada Plain is semiarid, with a yearly mean temperature of about 16 C. Mean monthly temperatures are highest in June (35°) and lowest in January (13°). Average annual precipitation is 32 cm (range 9.2–36.2 cm), of which about 50% falls during July, August, and September (Paulsen and Ares 1962).

Fecal pellets from black-tailed jackrabbits were collected from six vegetation types (habitats): (1) mesquite (*Prosopis glandulosa*) grass, (2) snakeweed (*Gutierrezia sarothrae*), (3) mixed shrub–grass, (4) black grama, (5) creosotebush (*Larrea tridentata*), and (6) tarbush (*Flourensia cernua*). These vegetation types are characteristic of desert grassland and

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desert shrublands (Humphrey 1958). Major grass species include black grama (*Bouteloua eriopoda*), mesa dropseed (*Sporobolus flexuosus*), fluffgrass (*Erioneuron pulchellum*), and threeawns (*Aristida* spp.). Abundant forbs include leatherweed croton (*Croton pottsii*), wooly paperflower (*Psilostrophe tagetinae*), silverleaf nightshade (*Solanum elaeagnifolium*), and other species. Shrubs include mesquite, creosotebush, and tarbush.

METHODS

Jackrabbit fecal material was collected from each vegetational type in June, August, and October 1988. The sample consisted of 15–20 pellets collected randomly on each date and in each of two replications of each vegetational type. Fresh pellets were identified by their shiny appearance. Field observations indicated that pellets lost their shiny appearance within a week of deposition. The pellets were dried and ground to pass through a 1.0-mm screen in a Wiley mill. The ground material was prepared as described by Bear and Hansen (1966) and Holechek (1982). Five microscopic slides were prepared from each sample, and 20 random fields were read from each slide (Holechek and Vavra 1981). Individual plant species were identified by comparison with known reference slides. All identifications were made by the senior author with an accuracy of 94%. Calculations of percent composition by weight were made following procedures outlined by Holechek and Gross (1982).

Microhistological examination of fecal material has some limitations in diet evaluations (Holechek et al. 1982). Problems are related to differential digestion of different species (Sidahmed et al. 1981), differential detection and recognition under a microscope (Westoby et al. 1976), and differential particle size reduction (Crocker 1959). In spite of these limitations, fecal analysis is one of the main methods for quantifying diet composition of wide-ranging herbivores.

Statistical analyses of dietary data were based on species counts using a split-plot, completely randomized design with vegetational type as the whole plot and sampling date as the split-plot. Differences among types, periods, and the interaction were analyzed using a categorical modeling procedure (Proc Catmod, SAS Institute 1985). Proc Catmod is a program for analyzing relative frequency data by chi-square tests.

Herbage standing crop (an estimate of herbage availability) was determined by clipping herbaceous species from ten 0.5 × 1.0-m quadrats, located randomly in each of the two replications within each vegetational type, at the time the fecal material was collected. Herbage was separated by species, oven-dried (70 C), and weighed. Shrub biomass was determined for the major species by dimension analysis as described by Ludwig et al. (1975). Preference indices were calculated as the ratio between the amount each species contributed to the diet divided by the composition in the standing crop (Krueger 1972). Only those preference indices greater than 2 are reported in this paper to indicate those species with a relatively high degree of preference.

RESULTS

Herbage Availability

Grasses contributed more than half of the herbaceous standing crop only on the black grama type (Fig. 1). Generally grass composition increased from June to August, except on the creosotebush type. Summer is the major growth period for the C_4 perennial grass species in this area (Pieper and Herbel 1982). Forbs contributed more than 50% to the plant standing crop on the mesquite-grass, black grama, and snakeweed types (Fig. 1). Shrubs were abundant (contributing about 20% of the standing crop) on the creosotebush, tarbush, and mixed shrub–grass types.

Diet Composition

Seasonal changes in jackrabbit diets appeared to be greater than standing crop availability for grasses, forbs, and shrubs (Fig. 2, Table 1). Generally, grass content of the diet peaked in August and declined until October (Fig. 2). Forb content of the diet changed little seasonally for pellets collected on the tarbush, creosotebush, and snakeweed types. Forbs comprised a larger percentage of the diet in June and October than in August on the mesquite-grass and black grama types. Shrubs generally contributed less than 25% of the diet, except for pellets collected from shrubby types at certain dates (e.g., October on the mesquite-grass type, October on the snakeweed type,

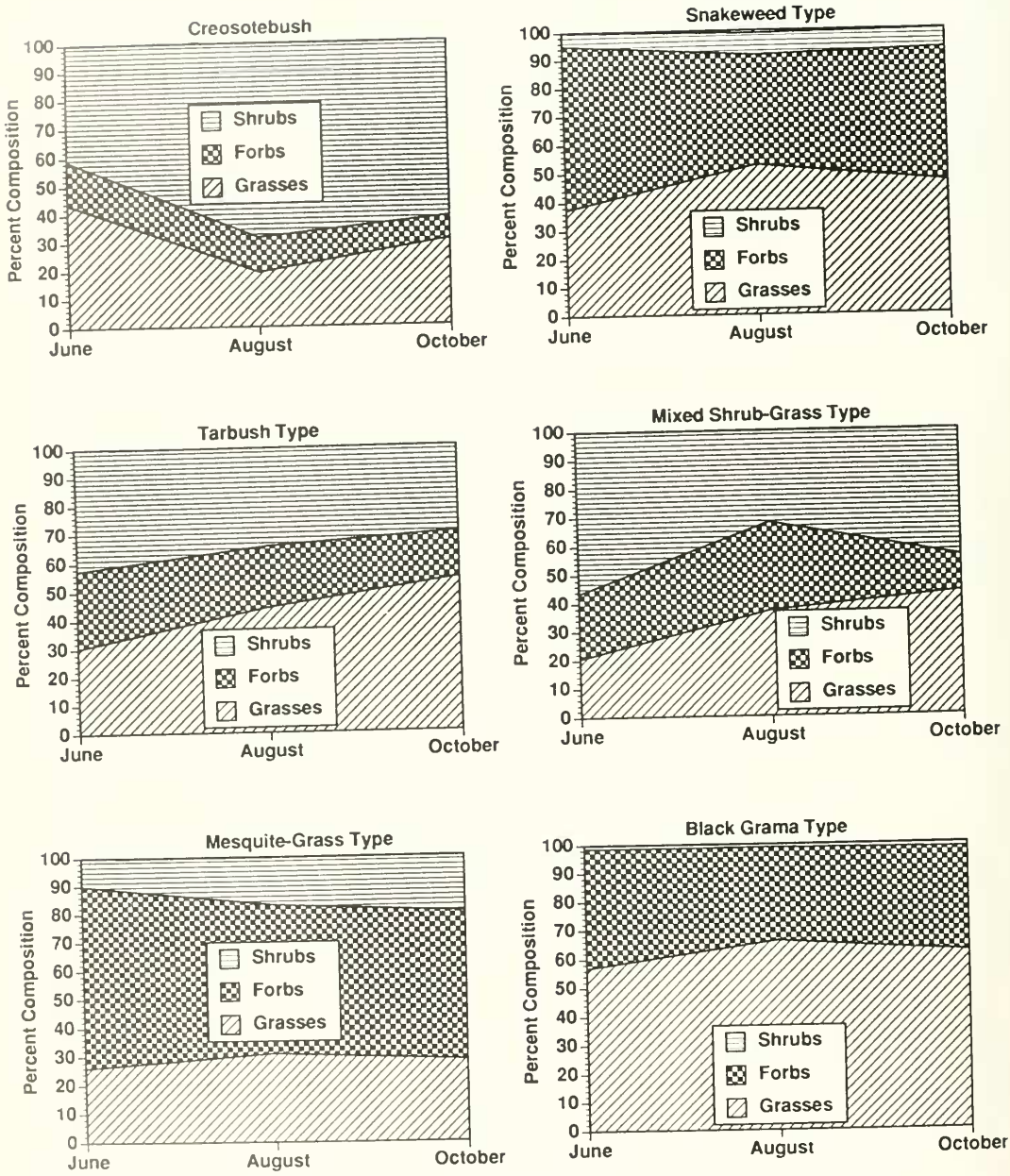

Fig. 1. Standing crop of grasses, forbs, and shrubs on different vegetation types.

June and October on the creosotebush and tarbush types).

Table 2 shows the vegetation type × date interaction was significant ($P < .05$) for several species. This interaction indicates these species did not constitute a similar percentage of the diet from June to October on the different vegetation types.

Dietary content of dropseeds varied significantly ($P < .01$) among seasons and vegetation types, and the vegetation type × date interaction was also significant (Table 2). Dropseed content of the diet was highest in pellets collected from the mixed shrub type and lowest from those collected in the tarbush type. In some types dropseed content of the diet was highest in June (e.g., mesquite-grass and snakeweed types), while in others (e.g., black grama

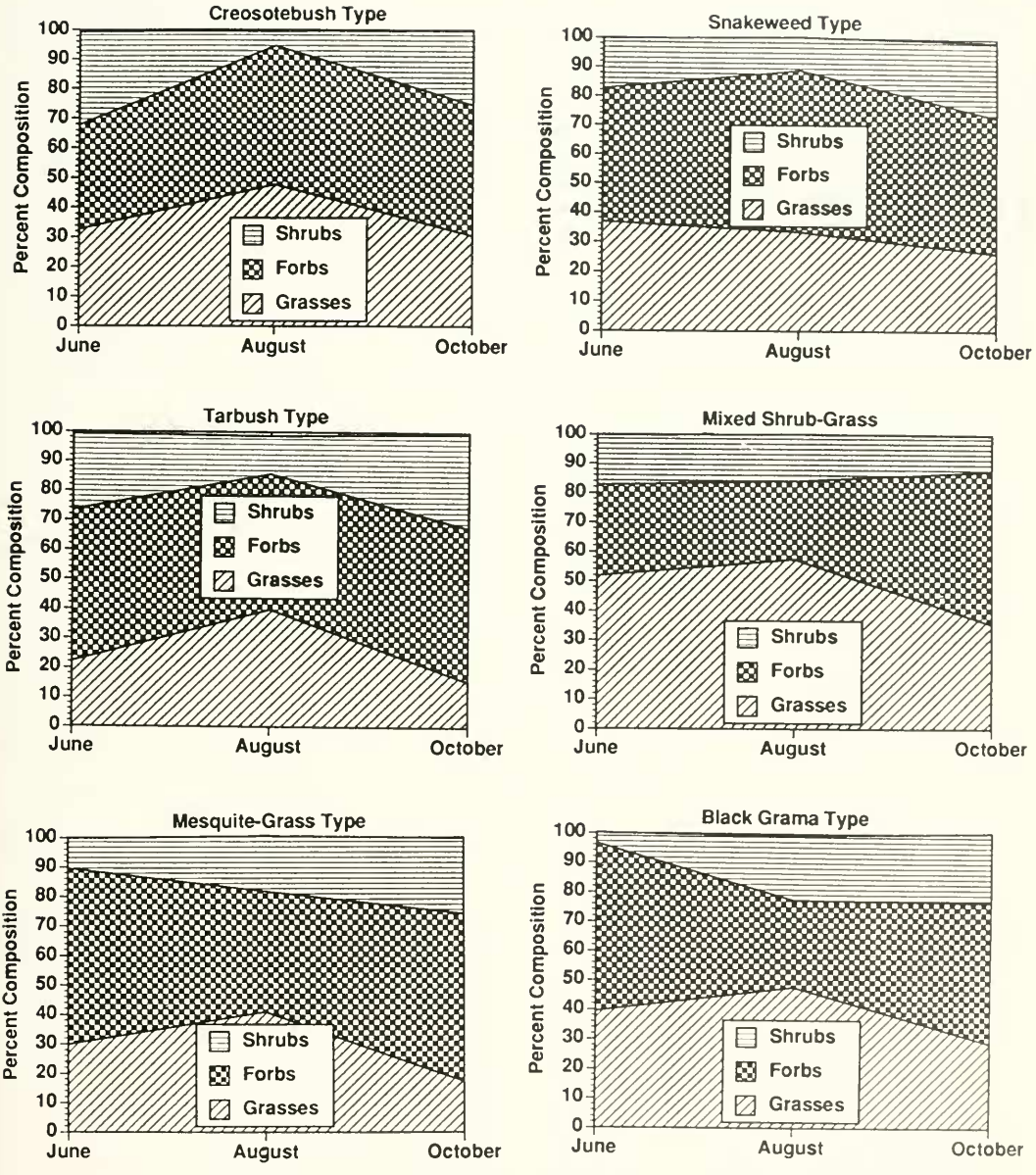

Fig. 2. Dietary content of grasses, forbs, and shrubs in pellets collected from different vegetation types.

and tarbush) it was highest in October. Dropseed content of pellets collected from the creosotebush type was consistent from June through October (Table 1).

Black grama content of pellets was not different ($P > .10$) among vegetational types, but was different among dates ($P < .10$; Table 2). In most cases black grama content of the diet peaked in August, but for some vegetational types the difference among dates was relatively small (e.g., mixed shrub type; Table 1). These inconsistencies contributed to the significant vegetational type × date interaction ($P < .01$; Table 2).

Dietary content of fluffgrass and threeawn grasses was generally low (Table 1). However, fluffgrass contributed more than 22% of the diet in June on the black grama type and more than

TABLE 1. Botanical content (%) of important plant species identified in black-tailed jackrabbit feces.

	Vegetation type																	
	Black grama			Mesquite-grass			Mixed shrub			Snakeweed			Creosotebush			Tarbush		
Species	June	August	October	June	August	October	June	August	October	June	August	October	June	August	October	June	August	October
Grasses																		
Dropseeds	9.5	9.5	17.6	20.8	12.0	10.2	26.4	24.5	17.8	12.3	9.7	10.7	15.0	15.2	17.0	2.9	0.2	9.4
Black grama	6.4	27.3	9.1	8.6	22.2	5.4	11.8	16.1	11.4	9.1	14.2	9.8	12.0	21.8	7.5	3.8	9.7	1.5
Fluffgrass	22.2	0	0.5	0	4.7	0.5	12.5	13.7	3.0	12.1	3.6	1.2	1.7	2.0	1.9	2.1	0.1	0
Threeawns	0.7	8.5	1.6	0.5	1.2	0.1	0.7	0.7	2.6	0.1	2.0	3.7	2.1	4.9	1.5	0	0	0
Total grasses	39.6	47.8	28.9	29.9	40.8	17.3	51.8	57.5	35.6	36.9	33.5	26.2	32.6	47.9	30.7	22.2	39.8	15.6
Forbs																		
Leatherweed croton	8.3	2.1	13.3	11.3	5.4	14.2	0.4	0	9.4	11.2	10.7	25.0	10.5	1.8	16.8	8.7	23.8	18.7
Dwarf dalea	9.0	0	7.3	0	2.0	0	2.8	9.5	0	0	0	0	0.3	10.3	0	9.1	0.1	0
Silverleaf nightshade	5.3	3.0	7.5	12.3	7.8	8.3	6.8	1.5	0.6	5.5	7.6	4.9	2.9	1.1	9.6	4.5	5.0	9.5
Wooly paperflower	0.3	4.1	1.6	3.3	8.0	12.9	5.1	1.5	1.2	1.1	0.9	0.6	0.6	2.8	0	0.1	1.2	0
Scarlet globemallow	0.1	0.3	2.2	5.2	8.5	4.9	1.9	0.3	13.2	3.3	10.9	1.4	6.5	2.4	5.8	6.8	4.8	8.4
Spectaclepod	4.3	2.9	0.3	0	0	0	3.0	0.1	0.1	5.4	11.1	0.1	0	0	0	0	0	0
Snakeweed	6.9	1.8	3.5	5.8	2.2	1.5	2.3	3.5	0.1	4.2	1.3	2.9	3.8	1.1	1.4	3.8	0.8	0.4
Total forbs	56.9	29.8	48.1	59.7	40.8	56.7	31.0	26.6	51.9	45.8	55.5	46.5	35.1	46.7	44.0	51.2	45.9	51.9
Shrubs																		
Mesquite	1.6	8.6	19.9	6.3	15.2	19.2	8.7	4.7	1.6	13.0	8.1	24.1	12.4	1.0	7.7	13.2	2.2	8.8
Yucca	1.1	2.8	2.4	0	1.5	2.3	6.4	8.9	1.4	0	0	0	7.2	0.4	1.3	1.6	1.8	0.5
Total shrubs	3.7	21.9	23.5	10.2	18.8	25.7	17.0	16.0	12.3	17.1	11.4	26.3	31.6	4.9	25.0	25.8	13.0	31.9

TABLE 2. Categorical analyses of botanical content of black-tailed jackrabbit diets on six vegetation types and three dates.

Grass[a]

Source	Degree of freedom	Chi-squares Ari	Boer	Mupo	Scbr	Spo	Erpu	Paob	Sele	Himu	Oth
Vegetation type	5	22.18°°	63.75^{NS}	7.25^{NS}	.47^{NS}	217.41°°	64.60°°	.47^{NS}	8.41^{NS}	226.63°°	13.96
Date	2	10.67°°	142.17°°	1.48^{NS}	.16^{NS}	60.37°°	38.33°°	.16^{NS}	2.38^{NS}	1.72^{NS}	2.92^{NS}
Type × date	10	20.70°	108.84°°	30.52°°	1.32^{NS}	162.54°°	68.93°°	1.32^{NS}	5.62^{NS}	3.88^{NS}	18.78°

[a]Ari = *Aristida* spp., Boer = *Bouteloua eriopoda*, Mupo = *Muhlenbergia porteri*, Scbr = *Scleropogon brevifolius*, Spo = *Sporobolus* spp., Erpu = *Erioneuron pulchellum*, Paob = *Panicum obtusum*, Sele = *Setaria leucopila*, Himu = *Hilaria mutica*, Oth = others.

Forbs[b]

Source	Degree of freedom	Chi-squares Bamu	Gusa	Pena	Dana	Eri	Lefe	Hyro	Crpo	Saib	Soel	Spsu	Psta	Diwi
Vegetation type	5	8.01^{NS}	35.82°°	11.74°	19.53°°	13.50°	25.81°°	41.98°°	187.86°°	3.37^{NS}	72.38°°	54.10°°	11.23^{+}	64.71°°
Date	2	43.05°°	27.91°°	36.90°°	6.28°	2.60^{NS}	0.71^{NS}	1.57^{NS}	135.23°°	1.34^{NS}	37.95°°	10.64°°	4.73^{NS}	9.14°
Type × date	10	17.98^{+}	38.08°°	96.15°°	157.31°°	44.79°°	35.06°°	36.06°°	131.23°°	8.99^{NS}	121.83°°	125.88°°	79.51°°	18.15^{NS}

[b]Bamu = *Baileya multiradiata*, Gusa = *Gutierrezia sarothrae*, Pena = *Perezia nana*, Dana = *Dalea nana*, Eri = *Eriogonum* spp., Lefe = *Lesquerella fendleria*, Hyro = *Hymenopappus robustus*, crop = *Croton pottsii*, Saib = *Salsola iberica*, Soel = *Solanum elaeagnifolium*, Spsu = *Sphaeralcea subhastata*, Psta = *Psilostrophe tagetina*, Diwi = *Dithyrea wislizenii*.

Shrubs[c]

Source	Degree of freedom	Chi-squares Kosp	Latr	Ziac	Eph	Atca	Prgl	Opu	Flce	Yuel	Oth
Vegetation type	5	2.11^{NS}	9.79°	41.21°°	3.50^{NS}	33.88°°	182.99°°	23.51°°	192.81°°	17.19°°	.90^{NS}
Date	2	.69^{NS}	12.04°°	.90^{NS}	3.55^{NS}	5.51^{+}	21.32°°	1.40^{NS}	.62^{NS}	14.88°°	.19^{NS}
Type × date	10	6.59^{NS}	29.03°°	5.12^{NS}	19.95^{NS}	23.16^{+}	359.51	32.51°°	28.11°°	95.72°°	4.03^{NS}

Kosp = *Koeberlinia spinosa*, Latr = *Larrea tridentata*, Ziac = *Zinnia acerosa*, Eph = *Ephaedra* spp., Atca = *Atriplex canescens*, Prgl = *Prosopis glandulosa*, Opu = *Opuntia* spp., Flce = *Flourencia cernua*, Yuel = *Yucca elata*.

$^{+}P < .10$ $^{\circ\circ}P < .01$
$^{\circ}P < .05$ NS = nonsignificant at .10 level

TABLE 3. Month and vegetation type when preference index exceeded 2.0 for all species in black-tailed jackrabbit diets on six vegetational types.

Species	Vegetational Type					
	Black grama	Mesquite-Grass	Mixed Shrub–Grass	Snakeweed	Creosotebush	Tarbush
Dropseed	June		June		Oct.	
Black grama		June, Aug., Oct.	Aug.	Oct.		
Fluffgrass	June, Oct.	Oct.		June	June	June
Abert's buckwheat				Oct.	June, Aug., Oct.	Aug.
Snakeweed						June
Desert baileya			Oct.			
Desert holly		Aug.	June, Oct.	Aug., Oct.	Oct.	
Dwarf dalea	Oct.					
Fendler's bladderpod	Aug., Oct.		June	June		
Globemallow		Aug., Oct.	Aug.		June, Oct.	June, Aug.
Hymenopappus		June				
Leatherweed croton		June, Aug.	Aug., Oct.	June, Aug.	June, Aug.	June
Rattlesnake weed	June				Oct.	
Silverleaf nightshade		June, Aug.	Aug.	June, Aug., Oct.		June, Aug.
Spectaclepod			Oct.	Oct.		
Wooly paperflower	Oct.	June, Oct.	June	June		
Mesquite		June		Aug.		
Yucca					June, Aug.	

12% in June and August on the mixed shrub type, and in June on the snakeweed type (Table 1). Threeawns contributed less than 9% of the diet on all dates and vegetational types.

Other grass species made small contributions to the diet. Plains bristlegrass (*Setaria leucopila*), vine mesquite (*Panicum obtusum*), and burrograss (*Scleropogon brevifolius*) did not differ in diets ($P > .10$) among vegetational types or dates, and the vegetational type × date interaction was not significant (Table 2).

Forb content of jackrabbit diets varied over time and vegetation type. For example, the content of leatherweed croton differed significantly ($P < .01$) among vegetation types and dates, and the vegetational type × date interaction also was significant ($P < .01$; Table 2). Its content varied from about 24% in pellets collected during August in the tarbush type to none in the mixed shrub type at the same time. Leatherweed croton appeared to be an important component of the diet on the black grama, mesquite-grass, and snakeweed types during most seasons (Table 1). Dietary content of other forbs was inconsistent among vegetational types and dates (Table 1). Russian thistle (*Salsola iberica*) was the only forb species with a nonsignificant ($P > .10$) vegetational type × date interaction (Table 2).

Shrub content of the jackrabbit diets was also inconsistent among vegetational types and dates. Mesquite contributed substantially to the diets on most vegetational types between June and October. Mesquite constituted more than 24% of the diets on the snakeweed type in October, but only 1% on the creosotebush type in August (Table 1). Yucca (*Yucca elata*) contributed more than 7% of the diet from the creosotebush type in June, but was not found in pellets collected from the snakeweed type on any date (Table 1). However, several shrubby species did not show a significant ($P > .10$) vegetational type × date interaction (crucifixion

thorn [*Koeberlinia spinosa*], creosotebush, zinnia [*Zinnia aceosa*], and ephedra [*Ephedra* spp.]).

Dietary Preference

The preference index was generally below 2 for most grass species (Table 3). However, jackrabbits apparently preferred black grama on all dates in the mesquite-grass type. Fluffgrass was preferred during some months on all types, except for the mixed shrub–grass type. The preference index exceeded 2 for fluffgrass in June on four of the vegetational types.

The preference index exceeded 2 for several forb species (Table 3). Those with a preference index exceeding 2 for more than six combinations of vegetational type and dates included desert holly (*Perezia nana*), fendler bladderpod (*Lesquerella fendleri*), globemallow (*Sphaeralcea* spp.), leatherweed croton, and silverleaf nightshade. Dwarf dalea (*Dalea nana*) was preferred only in October in the black grama type. Dabo et al. (1982) found dalea was highly preferred and comprised as much as 65% of the diets in the fall on grassland vegetational types. Mesquite and yucca showed a preference index above 2 for June and August on three vegetational types (Table 3).

Discussion

Black-tailed jackrabbits in southern New Mexico appear to be opportunistic feeders. Although this study and earlier ones indicate that as many as 30 plant species can be found in fecal samples at any one time, 5 or 6 species generally made up the bulk of the diet. Forbs often contribute a greater proportion of the diet than grasses, but the important forb species vary considerably among locations, seasons, and years. Leatherweed croton is perhaps the mainstay of the diet among the forbs, although several others, such as silverleaf nightshade and wooly paperflower (*Psilostrophe tagetinae*), contribute substantial amounts to the diets.

Dropseed, black grama, and fluffgrass appear to be the major grass species. Contrary to cattle, which utilize black grama mainly during the dormant season (Rosiere et al. 1975, Rodriguez et al. 1978), jackrabbits apparently consume more black grama during the summer growing season. Consequently, high jackrabbit densities could reduce the amount of black grama available for cattle later in the year.

Mesquite appears to be the main shrubby species in the diets, although preference for mesquite was not high. Other important shrubs varied considerably over time and space.

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